cadence®

General_SI_Simulation_Tutorial_1

Product Version 16.6
July 2014

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Contents

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Introduction

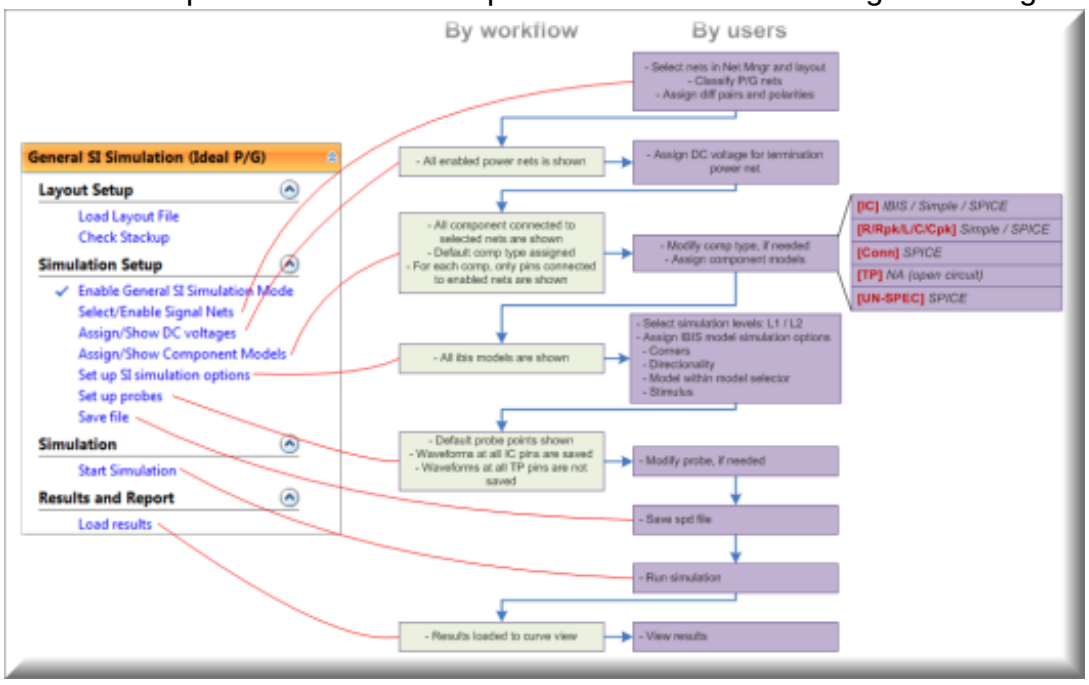
This tutorial introduces how to perform simulation with SPEED2000 **General SI Simulation (Ideal P/G)** workflow.

Overview

The newly introduced SPEED2000 **General SI Simulation (Ideal P/G)** workflow is for general purpose signal integrity simulations without considering the non-ideal power/ground effects. Specifically,

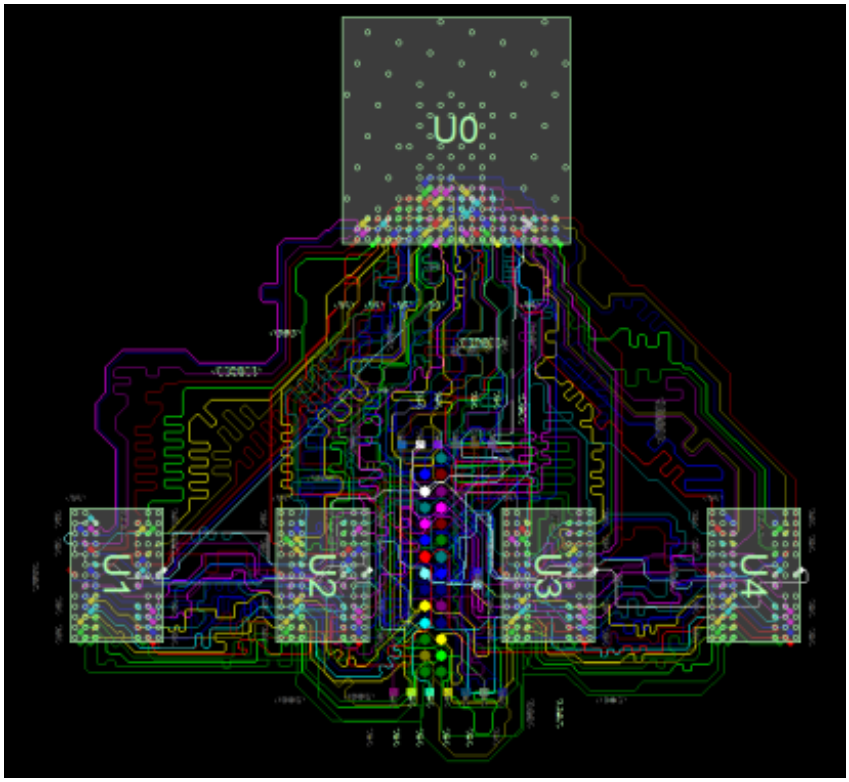
- Level 1 – Trace and via couplings not considered, ideal P/G
- Level 2 – Trace and via couplings considered, ideal P/G

The main steps for simulation setup are shown in the following block diagram.

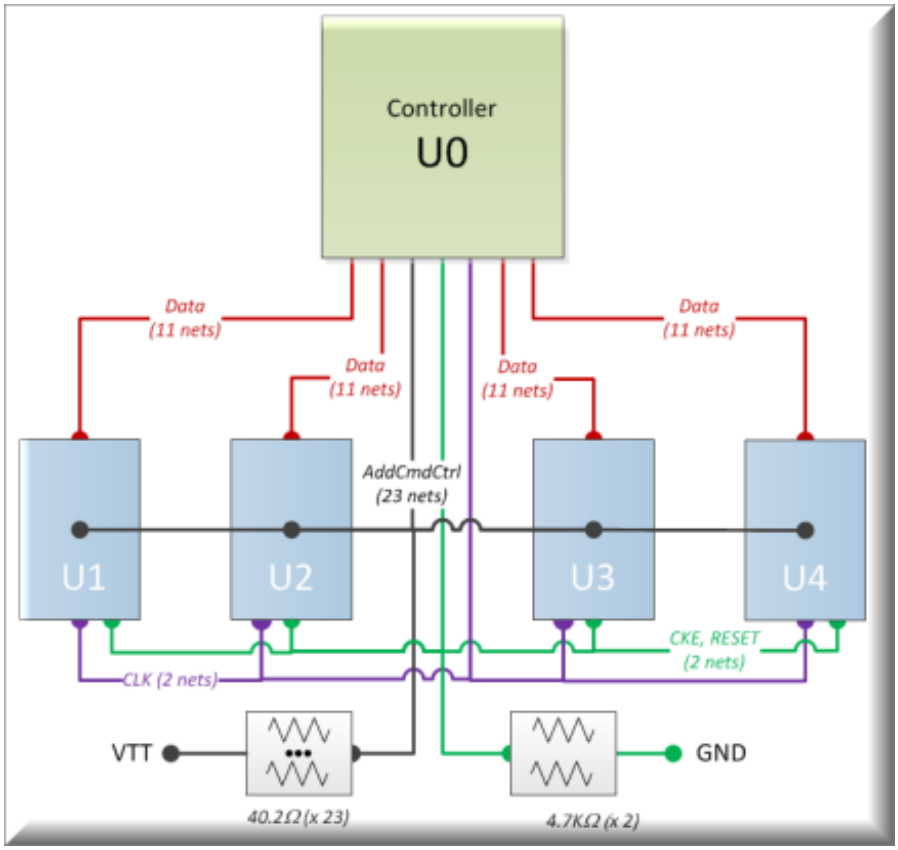


Tutorial Summary

The sample case used in this tutorial contains one controller and four DRAMs as shown below.



In this tutorial, all DDR nets are included in analysis. The topology is as the following figure shows.



The following three original files are used in this tutorial:

- Tutorial_GSI.spd – layout file
- dram_IO.ibs – IBIS file containing DRAM buffer models
- ctrl_IO.ibs – IBIS file containing Ctrl buffer models
- They are all located in: `<INSTALL_DIR>\SpeedXP\Samples\SPEED2000\General SI Simulation\Examples_PreSetup\`

The completed sample and IBIS files (with step by step setup introduced in this tutorial) are also provided and located in:

- `<INSTALL_DIR>\SpeedXP\Samples\SPEED2000\General SI Simulation\Examples_PostSetup\Tutorial-1`

General SI Simulation (Ideal P/G) workflow will lead user to:

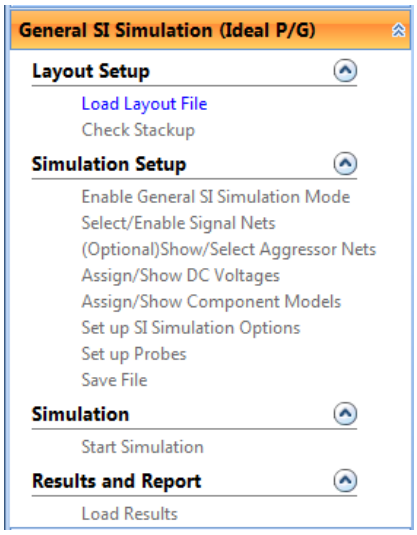
- Setup simulation parameters
- Run simulation
- View simulation results

2

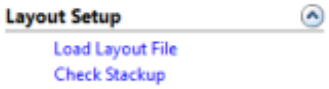
Layout Setup

This chapter describes how to load layout file and check stackup.

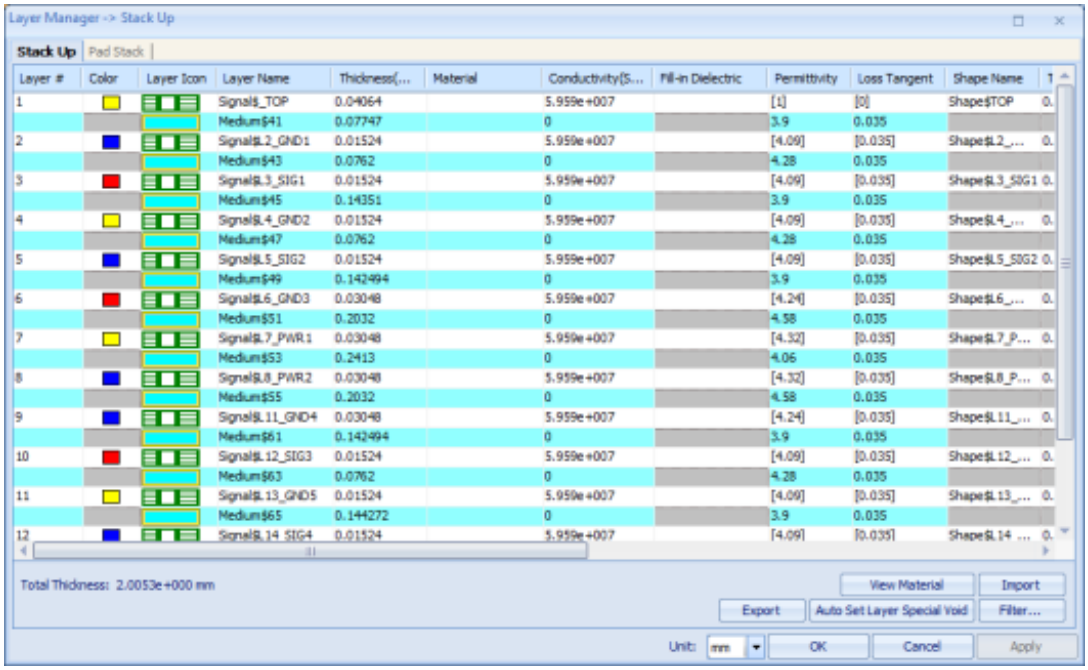
1. Launch **SPEED2000 Generator** , and select the **General SI Simulation (Ideal P/G)** workflow.



2. Click **Load Layout File** to load tutorial_GSI.spd.
   The workflow step **Check Stackup** is enabled.



3. Click **Check Stackup** to open the **Layer manager -> Stack Up** window.



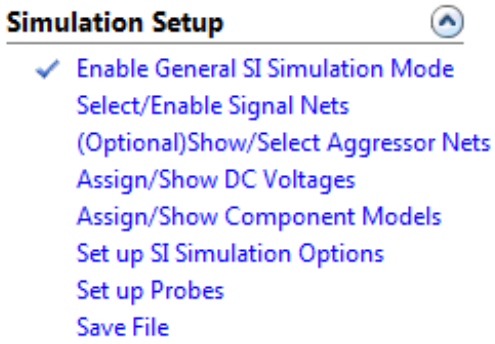
4. Check the stackup and edit as desired (no changes in this example).
5. Click **OK** to exit the window.

3

Simulation Setup

This chapter introduces how to set up simulation parameters for general SI simulation.

Click **Enable General SI Simulation Mode** to enable General SI simulation mode.

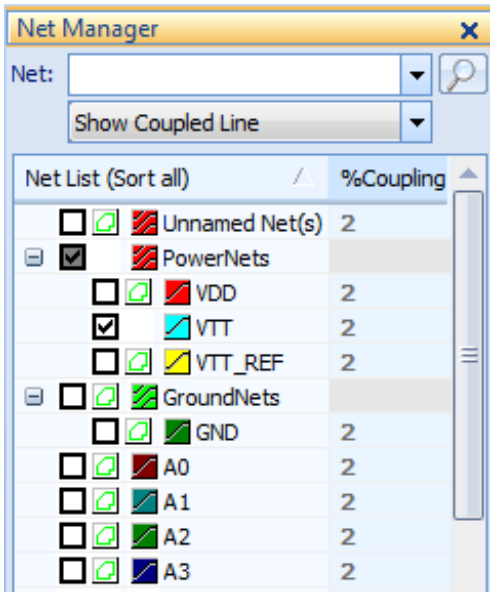


When enabled, a check mark ✓ appears ahead the workflow step. And all other related steps are enabled.

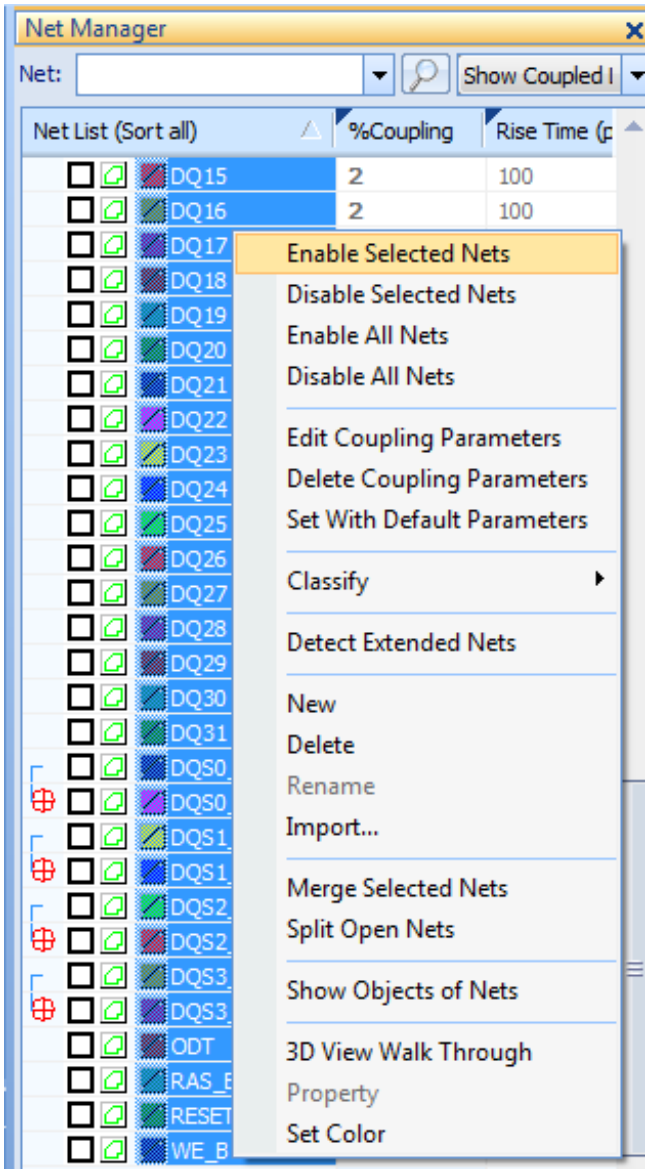
Enabling Simulation Nets

To perform general SI simulation with SPEED2000, you'll need to select simulation nets first and define the differential pair property.

1. Click **Select/Enable Signal Nets** in the **Workflow** pane.
   The **Net Manager** appears in the right side of the window.
2. Select to enable power net **VTT** .



3. Choose all signal nets.
4. Right-click and choose **Enable Selected Nets** from the pop-up menu.



All selected nets are enabled.

Icon

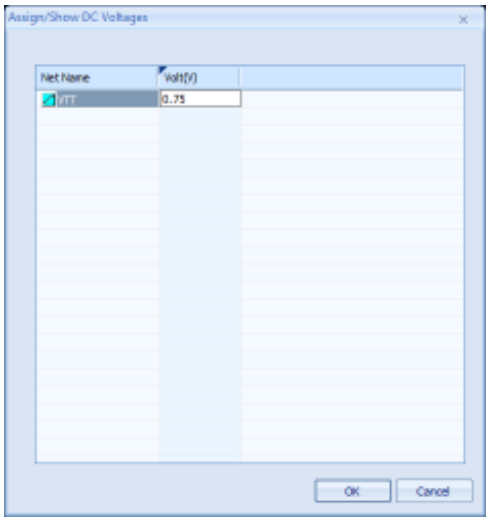
The diff-pair and polarity are guessed out automatically.

- If the diff-pair is not guessed out, choose both positive and negative nets, right-click and choose **Classify as diff pair** to define it manually.
- If the polarity is not guessed out, right-click the positive net and choose **Switch Polarity** to define it manually.

Assigning DC Voltage

If power or ground nets are enabled as simulation nets, the DC voltage should be assigned before simulation.

1. Click **Assign/Show DC Voltages** in the **Workflow** pane.
   The **Assign/Show DC Voltages** window opens.
2. Input **0.75V** for **VTT** net like the following figure shows.



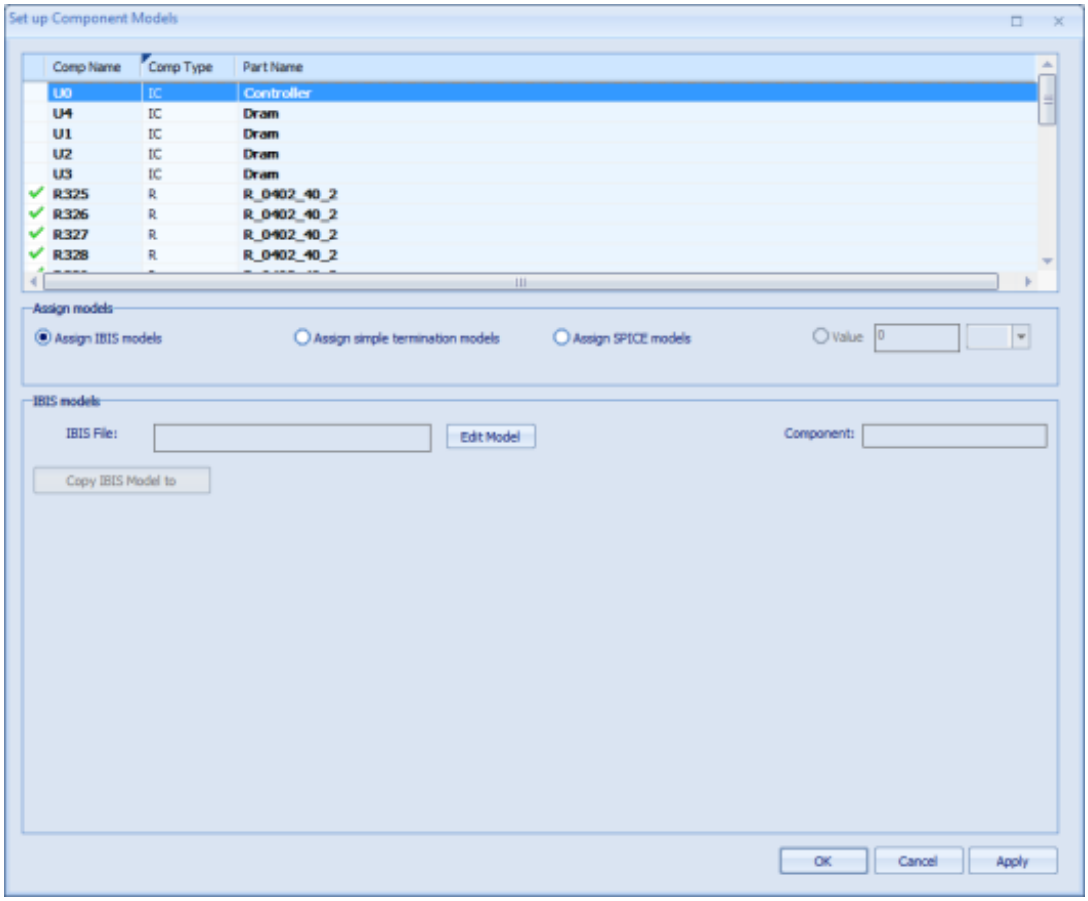
3. Click **OK** .

Assigning Component Models

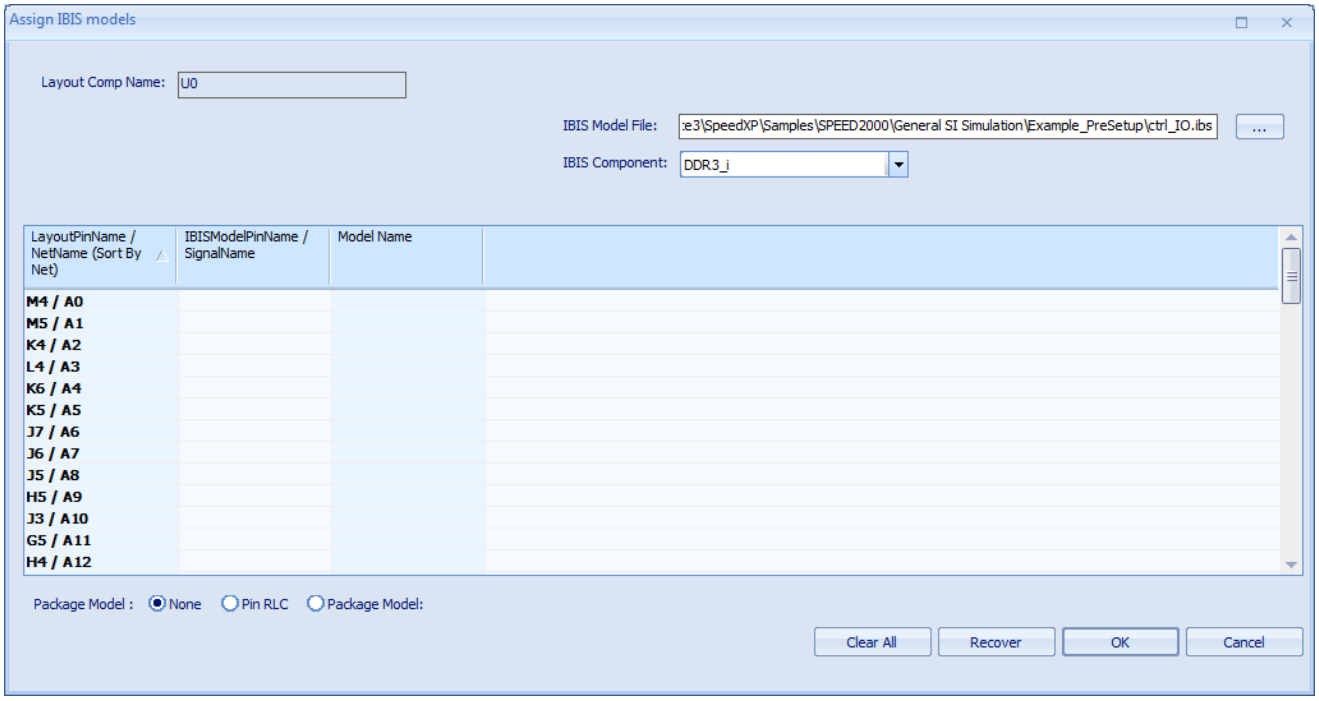
This section introduces how to assign models to all components.

Assigning IBIS Model to IC Component U0

1. Click **Assign/Show Component Models** in the **Workflow** pane.
   The **Set up Component Models** window opens.
2. Select to highlight component **U0** and click the **Edit Model** button.

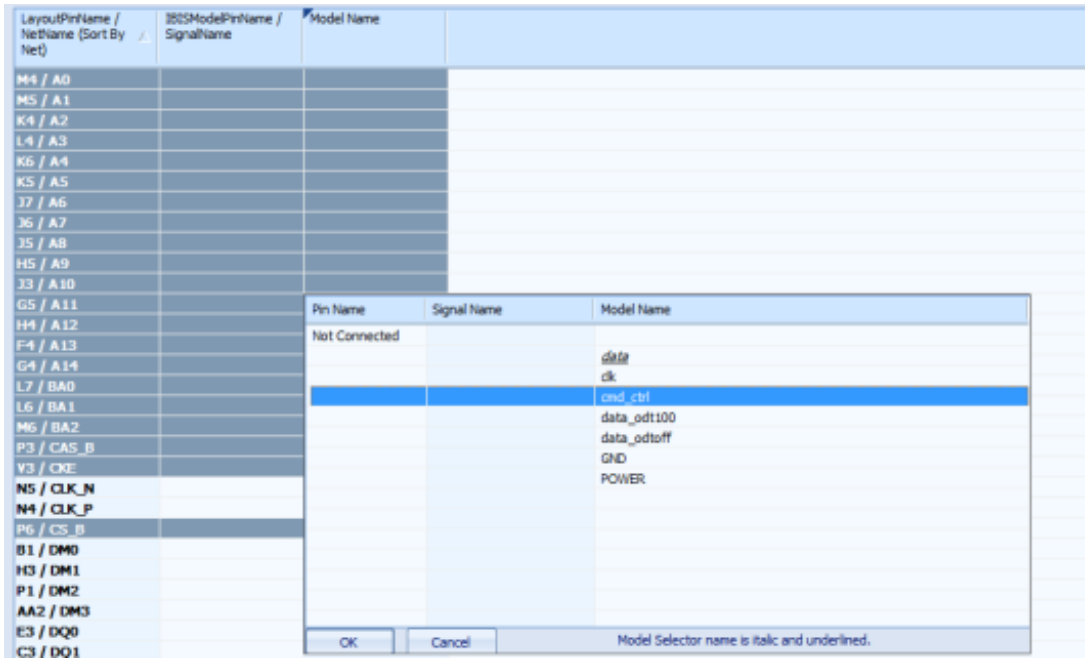


   The **Assign IBIS models** window opens.
3. Browse to load the IBIS file ctrl_IO.ibs.



The IBIS file is loaded.

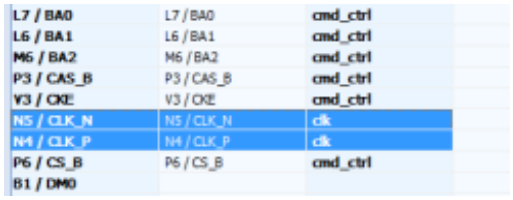
4. Use **Shift** and **Ctrl** keys to select multiple nets **A0** – **CKE** , **CS_B** , **ODT** , **RAS_B** , **RESET_B** , and **WE_B** .
5. Click the icon in the field of **Model Name** column and select **cmd_ctrl** from the pop-up window.



6. Click **OK** .
   The selected nets are assigned with the model **cmd_ctrl** .

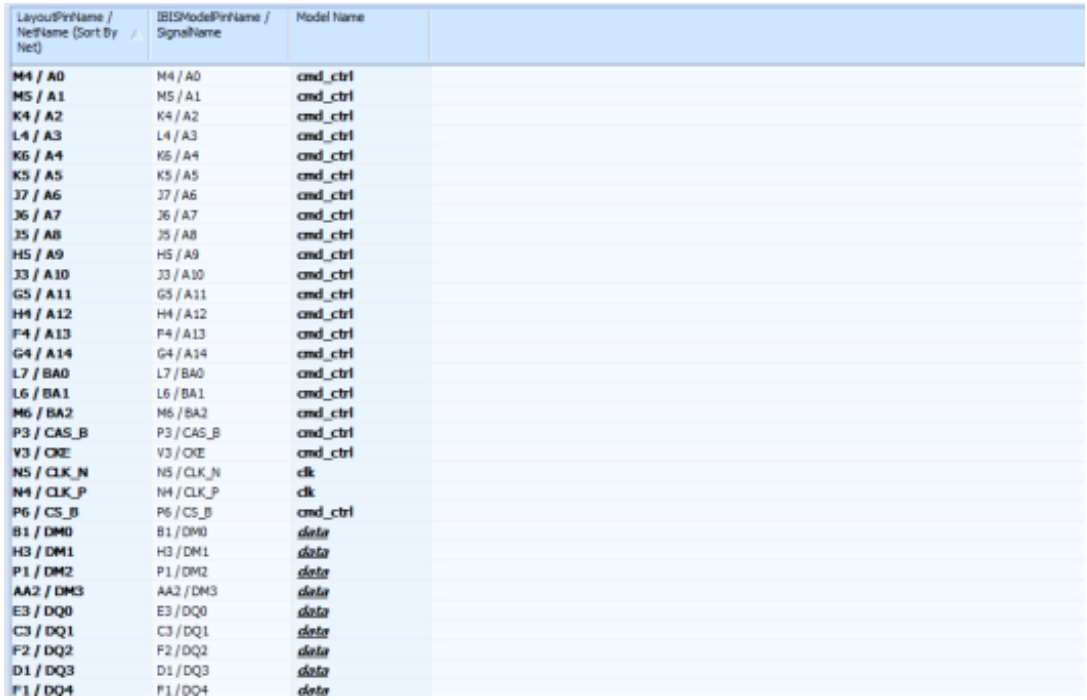
LayoutPinName / NetName (Sort By Net)	IBISModelPinName / SignalName	Model Name
M4 / A0	M4 / A0	cmd_ctrl
M5 / A1	M5 / A1	cmd_ctrl
K4 / A2	K4 / A2	cmd_ctrl
L4 / A3	L4 / A3	cmd_ctrl
K6 / A4	K6 / A4	cmd_ctrl
K5 / A5	K5 / A5	cmd_ctrl
J7 / A6	J7 / A6	cmd_ctrl
J6 / A7	J6 / A7	cmd_ctrl
J5 / A8	J5 / A8	cmd_ctrl
H5 / A9	H5 / A9	cmd_ctrl
J3 / A10	J3 / A10	cmd_ctrl
G5 / A11	G5 / A11	cmd_ctrl
H4 / A12	H4 / A12	cmd_ctrl
F4 / A13	F4 / A13	cmd_ctrl
G4 / A14	G4 / A14	cmd_ctrl
L7 / BA0	L7 / BA0	cmd_ctrl
L6 / BA1	L6 / BA1	cmd_ctrl
M6 / BA2	M6 / BA2	cmd_ctrl
P3 / CAS_B	P3 / CAS_B	cmd_ctrl
V3 / CKE	V3 / CKE	cmd_ctrl
N5 / CLK_N		
N4 / CLK_P		
P6 / CS_B	P6 / CS_B	cmd_ctrl
B1 / DM0		

7. Repeat the above steps to assign nets **CLK_N** and **CLK_P** with the model **clk** .

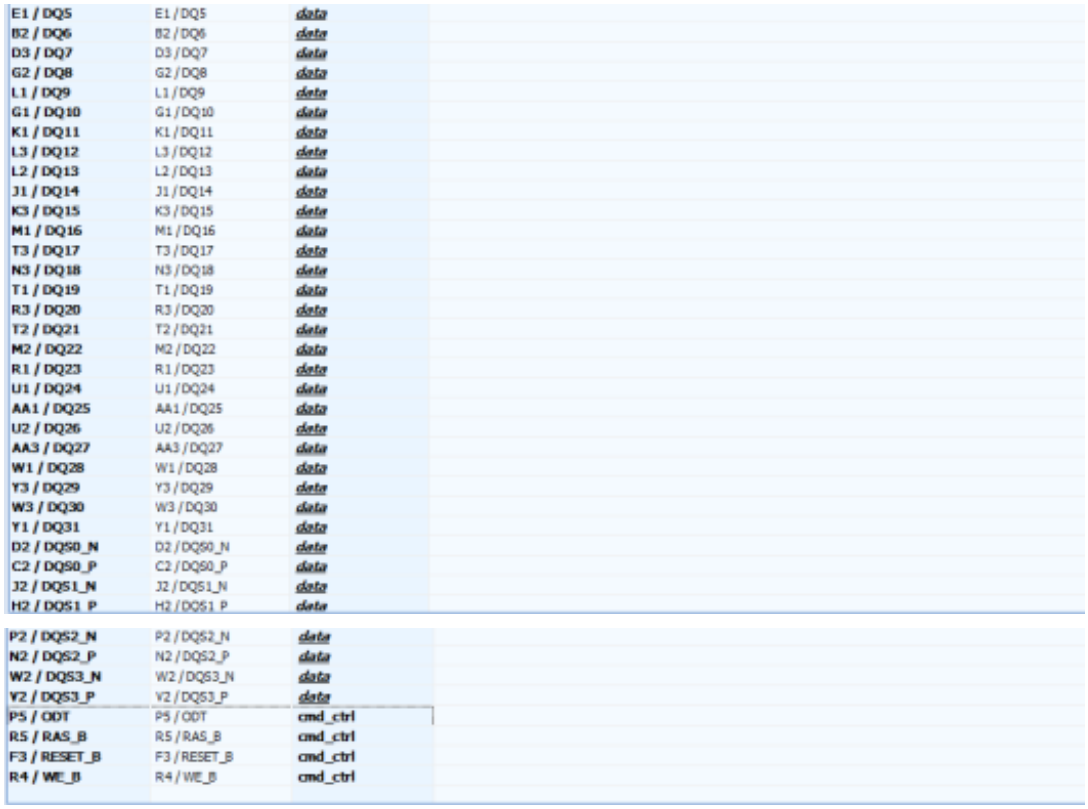


L7 / BA0	L7 / BA0	cmd_ctrl
L6 / BA1	L6 / BA1	cmd_ctrl
M6 / BA2	M6 / BA2	cmd_ctrl
P3 / CAS_B	P3 / CAS_B	cmd_ctrl
V3 / CKE	V3 / CKE	cmd_ctrl
N5 / CLK_N	N5 / CLK_N	clk
N4 / CLK_P	N4 / CLK_P	clk
P6 / CS_B	P6 / CS_B	cmd_ctrl
B1 / DM0		

8. Repeat the above steps to assign nets **DM0** – **DQS3_P** with the model **data** .
   All nets are assigned with IBIS models.

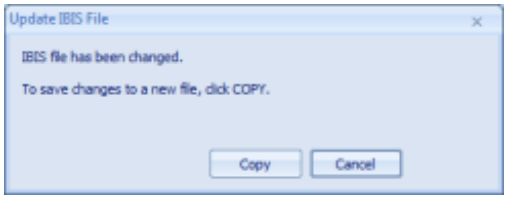


LayoutPinName / NetName (Sort By Net)	IBISModelPinName / SignalName	Model Name
M4 / A0	M4 / A0	cmd_ctrl
M5 / A1	M5 / A1	cmd_ctrl
K4 / A2	K4 / A2	cmd_ctrl
L4 / A3	L4 / A3	cmd_ctrl
K6 / A4	K6 / A4	cmd_ctrl
K5 / A5	K5 / A5	cmd_ctrl
J7 / A6	J7 / A6	cmd_ctrl
J6 / A7	J6 / A7	cmd_ctrl
J5 / A8	J5 / A8	cmd_ctrl
H5 / A9	H5 / A9	cmd_ctrl
J3 / A10	J3 / A10	cmd_ctrl
G5 / A11	G5 / A11	cmd_ctrl
H4 / A12	H4 / A12	cmd_ctrl
F4 / A13	F4 / A13	cmd_ctrl
G4 / A14	G4 / A14	cmd_ctrl
L7 / BA0	L7 / BA0	cmd_ctrl
L6 / BA1	L6 / BA1	cmd_ctrl
M6 / BA2	M6 / BA2	cmd_ctrl
P3 / CAS_B	P3 / CAS_B	cmd_ctrl
V3 / CKE	V3 / CKE	cmd_ctrl
N5 / CLK_N	N5 / CLK_N	clk
N4 / CLK_P	N4 / CLK_P	clk
P6 / CS_B	P6 / CS_B	cmd_ctrl
B1 / DM0	B1 / DM0	data
H3 / DM1	H3 / DM1	data
P1 / DM2	P1 / DM2	data
AA2 / DM3	AA2 / DM3	data
E3 / DQ0	E3 / DQ0	data
C3 / DQ1	C3 / DQ1	data
F2 / DQ2	F2 / DQ2	data
D1 / DQ3	D1 / DQ3	data
F1 / DQ4	F1 / DQ4	data

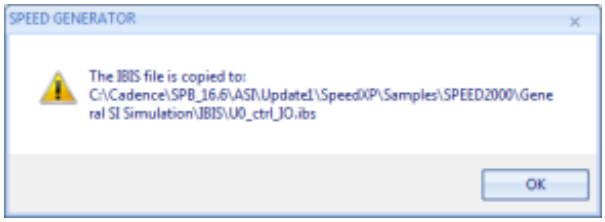


E1 / DQ5	E1 / DQ5	data
B2 / DQ6	B2 / DQ6	data
D3 / DQ7	D3 / DQ7	data
G2 / DQ8	G2 / DQ8	data
L1 / DQ9	L1 / DQ9	data
G1 / DQ10	G1 / DQ10	data
K1 / DQ11	K1 / DQ11	data
L3 / DQ12	L3 / DQ12	data
L2 / DQ13	L2 / DQ13	data
J1 / DQ14	J1 / DQ14	data
K3 / DQ15	K3 / DQ15	data
M1 / DQ16	M1 / DQ16	data
T3 / DQ17	T3 / DQ17	data
N3 / DQ18	N3 / DQ18	data
T1 / DQ19	T1 / DQ19	data
R3 / DQ20	R3 / DQ20	data
T2 / DQ21	T2 / DQ21	data
M2 / DQ22	M2 / DQ22	data
R1 / DQ23	R1 / DQ23	data
U1 / DQ24	U1 / DQ24	data
AA1 / DQ25	AA1 / DQ25	data
U2 / DQ26	U2 / DQ26	data
AA3 / DQ27	AA3 / DQ27	data
W1 / DQ28	W1 / DQ28	data
Y3 / DQ29	Y3 / DQ29	data
W3 / DQ30	W3 / DQ30	data
Y1 / DQ31	Y1 / DQ31	data
D2 / DQS0_N	D2 / DQS0_N	data
C2 / DQS0_P	C2 / DQS0_P	data
J2 / DQS1_N	J2 / DQS1_N	data
H2 / DQS1_P	H2 / DQS1_P	data
P2 / DQS2_N	P2 / DQS2_N	data
N2 / DQS2_P	N2 / DQS2_P	data
W2 / DQS3_N	W2 / DQS3_N	data
Y2 / DQS3_P	Y2 / DQS3_P	data
P5 / ODT	P5 / ODT	cmd_ctrl
R5 / RAS_B	R5 / RAS_B	cmd_ctrl
F3 / RESET_B	F3 / RESET_B	cmd_ctrl
R4 / WE_B	R4 / WE_B	cmd_ctrl

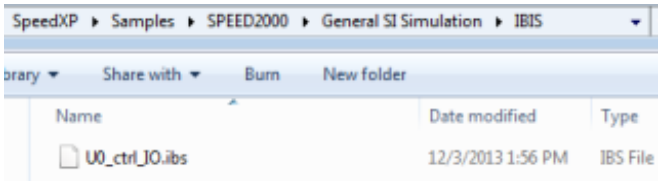
9. Check the newly generated models and click **OK** .
   The **Update IBIS File** dialog box opens to confirm the changes.



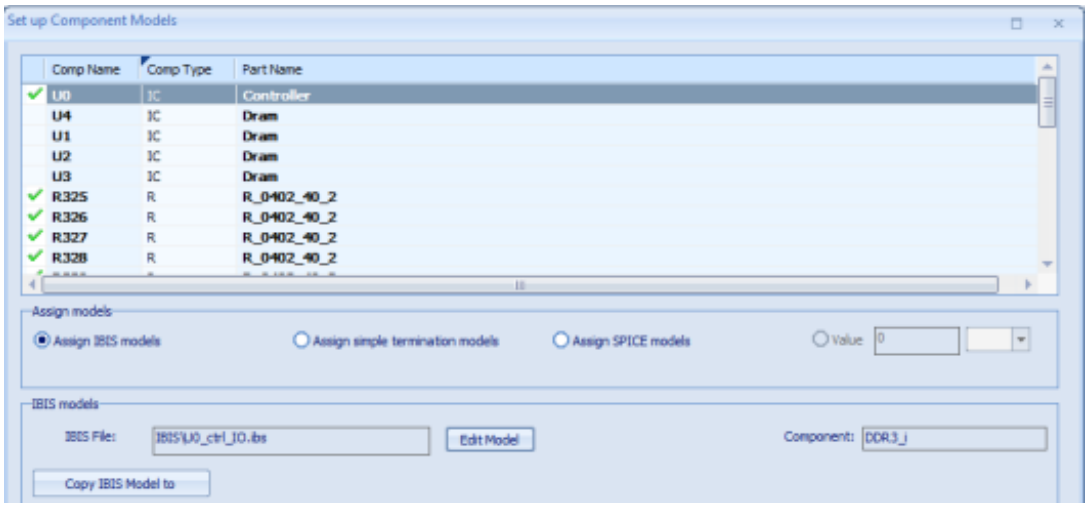
10. Click **Copy** .
    A dialog box opens.



11. Click **OK** to create a new IBIS model.
    The **Assign IBIS models** window quits and a pin matched component IBIS model for controller **U0** is generated, located in the sub-folder named **IBIS** under the project folder.

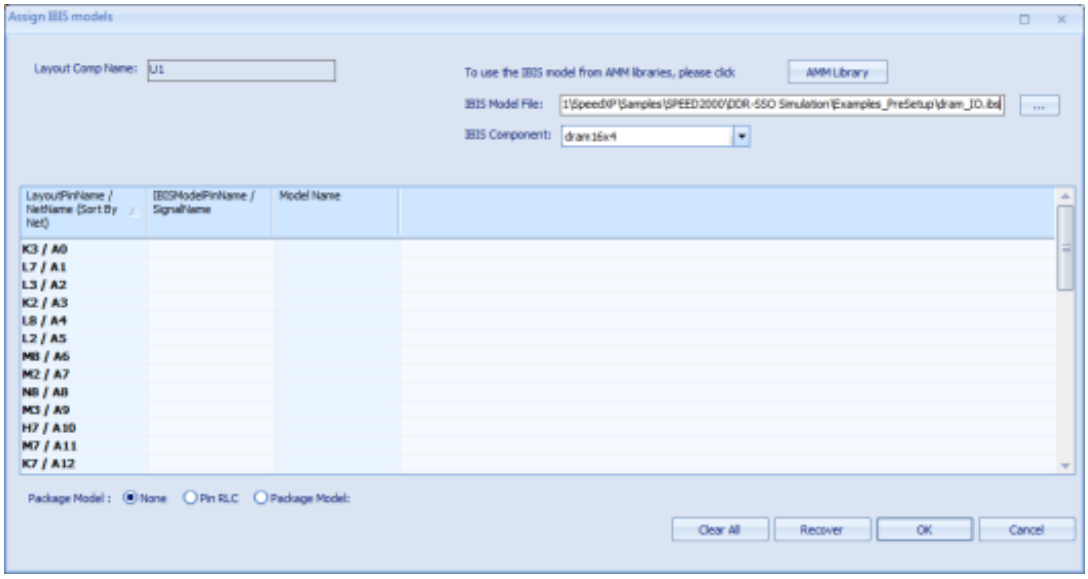


A green check mark appears ahead **U0** in the **Set up Component Models** window.



Assigning IBIS Model to IC Component U1

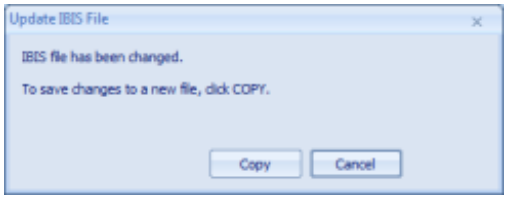
1. Select to highlight component **U1** and click the **Edit Model** button.
   The **Assign IBIS models** window opens.
2. Browse to load the IBIS file dram_IO.ibs.



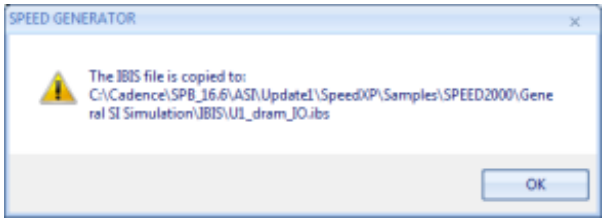
   The IBIS file is loaded.
3. Repeat the steps described in the above section to assign nets **A0** – **CKE** , **CS_B** , **ODT** , **RAS_B** , **RESET_B** , and **WE_B** with the model **INPUT** .
4. Assign nets **CLK_N** and **CLK_P** with the model **CLKIN** .
5. Assign nets **DM0** – **DQ_7** with the model **DQ** .
6. Assign nets **DQS0_N** and **DQS0_P** with the model **DQS** .
   All nets are assigned with the IBIS models.

LayoutPinName / NetName (Sort By Net)	IBISModelPinName / SignalName	Model Name
K3 / A0	K3 / A0	INPUT
L7 / A1	L7 / A1	INPUT
L3 / A2	L3 / A2	INPUT
K2 / A3	K2 / A3	INPUT
L8 / A4	L8 / A4	INPUT
L2 / A5	L2 / A5	INPUT
M8 / A6	M8 / A6	INPUT
M2 / A7	M2 / A7	INPUT
N8 / A8	N8 / A8	INPUT
M3 / A9	M3 / A9	INPUT
H7 / A10	H7 / A10	INPUT
M7 / A11	M7 / A11	INPUT
K7 / A12	K7 / A12	INPUT
N3 / A13	N3 / A13	INPUT
N7 / A14	N7 / A14	INPUT
J2 / BA0	J2 / BA0	INPUT
K8 / BA1	K8 / BA1	INPUT
J3 / BA2	J3 / BA2	INPUT
G3 / CAS_B	G3 / CAS_B	INPUT
G9 / CKE	G9 / CKE	INPUT
G7 / CLK_N	G7 / CLK_N	CLKIN
F7 / CLK_P	F7 / CLK_P	CLKIN
H2 / CS_B	H2 / CS_B	INPUT
B7 / DM0	B7 / DM0	DQ
B3 / DQ0	B3 / DQ0	DQ
C7 / DQ1	C7 / DQ1	DQ
C2 / DQ2	C2 / DQ2	DQ
C8 / DQ3	C8 / DQ3	DQ
E3 / DQ4	E3 / DQ4	DQ
E8 / DQ5	E8 / DQ5	DQ
D2 / DQ6	D2 / DQ6	DQ
E7 / DQ7	E7 / DQ7	DQ
D3 / DQS0_N	D3 / DQS0_N	DQS
C3 / DQS0_P	C3 / DQS0_P	DQS
G1 / ODT	G1 / ODT	INPUT
F3 / RAS_B	F3 / RAS_B	INPUT
N2 / RESET_B	N2 / RESET_B	INPUT
H3 / WE_B	H3 / WE_B	INPUT

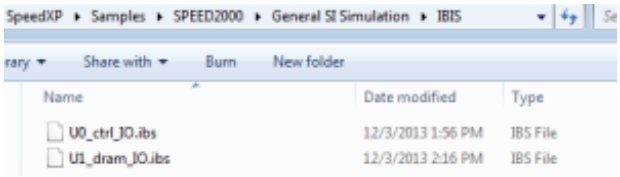
7. Check the newly generated models and click **OK** .
   The **Update IBIS File** dialog box opens to confirm changes.



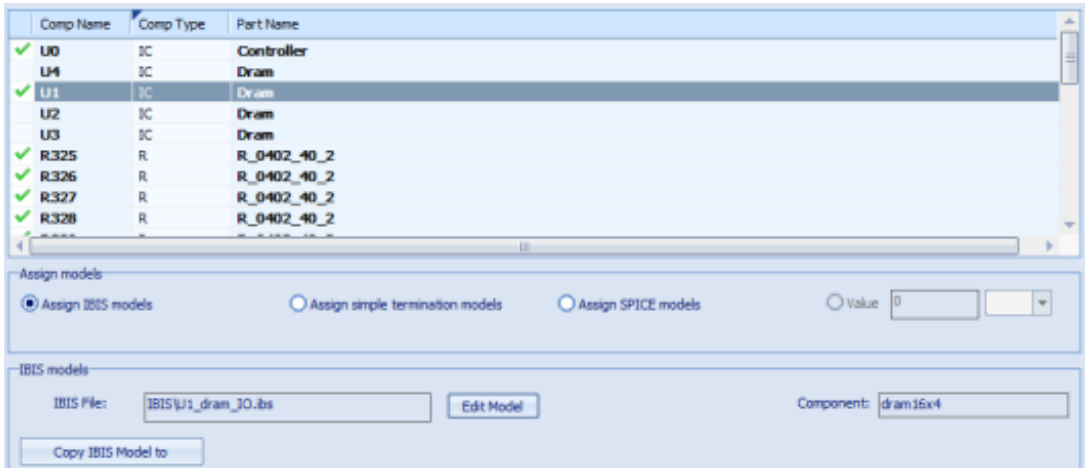
8. Click **Copy** .
   A dialog box opens.



9. Click **OK** to create a new IBIS model.
   The **Assign IBIS models** window quits and a pin matched component IBIS model for controller **U1** is generated, located in the sub-folder named **IBIS** under the project folder.

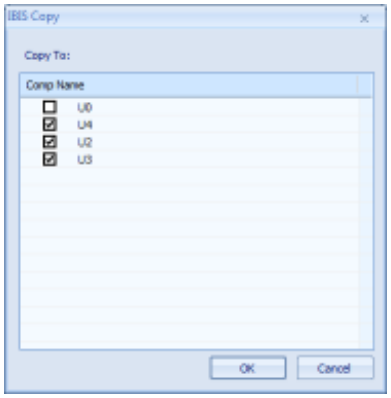


A green check mark appears ahead **U1** in the **Set up Component Models** window.

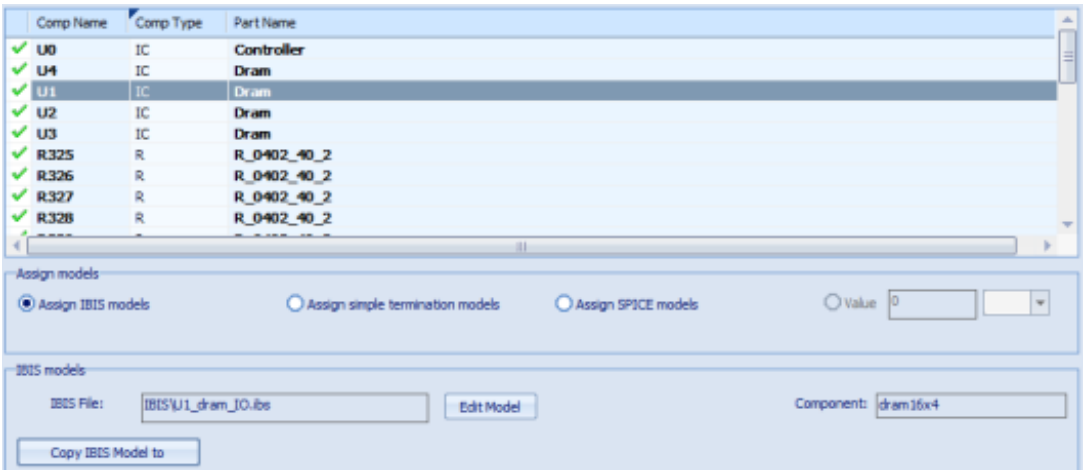


Copying IBIS Model to U2, U3 and U4 from U1

1. Click the **Copy IBIS Model to** button.
   The **IBIS Copy** window opens.
2. Select to check the components **U4** , **U2** and **U3** (uncheck **U0**).



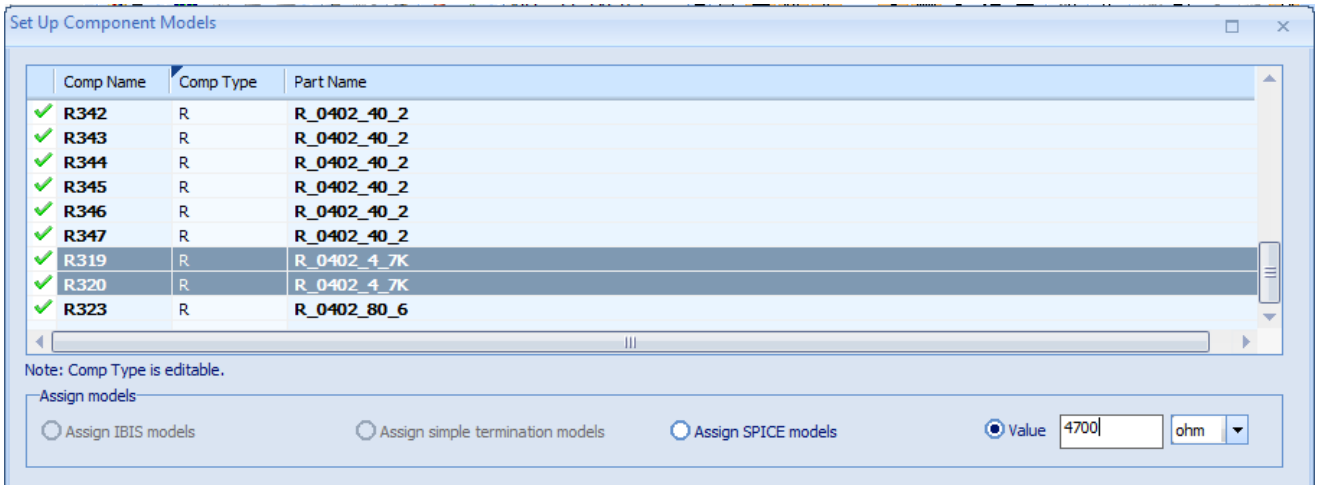
3. Click **OK** .
   All nets for component **U2** , **U3** and **U4** are assigned with IBIS models. A green check mark appears ahead components **U4** , **U2** and **U3** in the **Set up Component Models** window.



Defining Passive Component Value

The value of passive component is generated automatically by default. It is changeable. You can check and modify it as desired.

1. Select components **R319** and **R320** .
2. Input **4700ohm** in the field of **Value** .



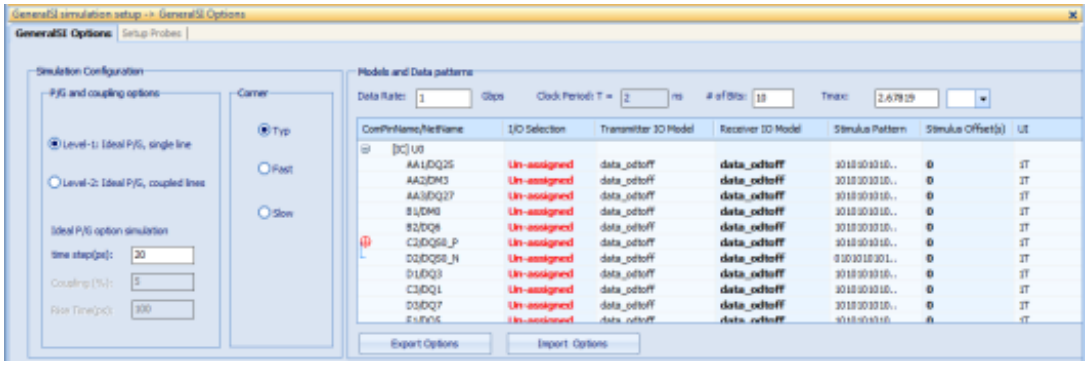
3. Click **OK** .
   The **Set up Component Models** window quits.

SI Simulation Options Setup

This section introduces how to set up SI simulation options.

Click **Set up SI Simulation Options** in the **Workflow** pane.

The **GeneralSI simulation setup -> GeneralSI Options** pane appears at the bottom of the window.



The pane contains two tabs: **GeneralSI Options** and **Setup Probes** .

General SI Options

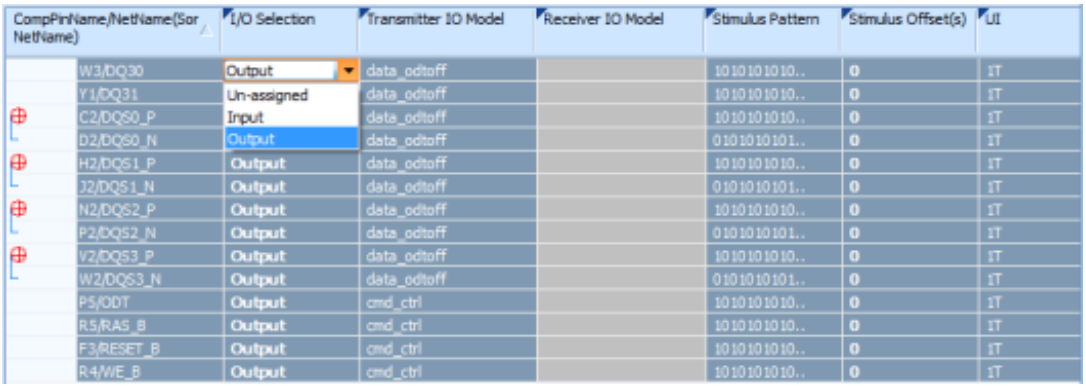
1. Input the following models and data parameters:
   - **Data Rate** : 1.333Gbps
   - **# of Bits** : 10
   - **Tmax** : 15ns

2. Click the column title **CompPinName/Netname** to reorder the nets alphabetically.

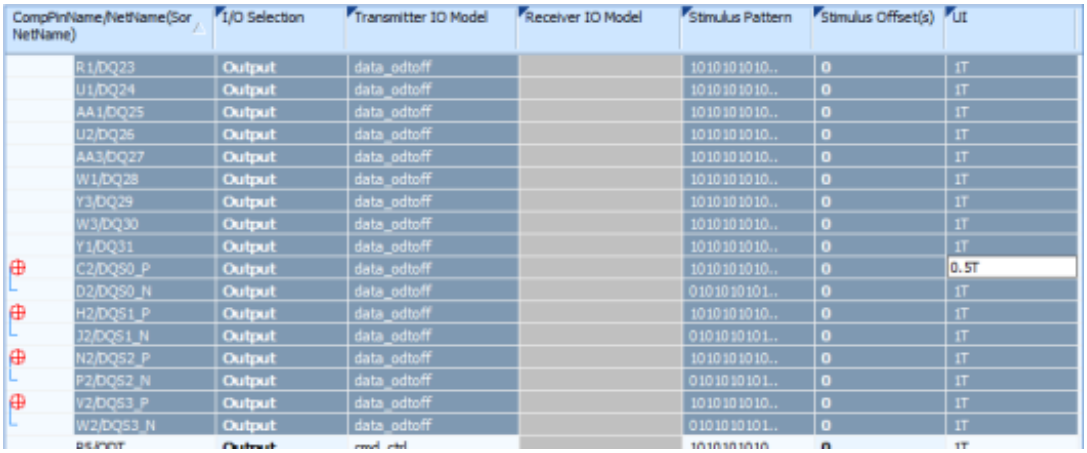
CompPinName/NetName(Sor NetName)	I/O Selection	Transmitter IO Model	Receiver IO Model	Stimulus Pattern	Stimulus Offset(s)	UI
[IC] U0						
M4/A0	Un-assigned	cmd_ctrl	**cmd_ctrl**	10 10 10 10 10..	**0**	1T
M5/A1	Un-assigned	cmd_ctrl	**cmd_ctrl**	10 10 10 10 10..	**0**	1T
K4/A2	Un-assigned	cmd_ctrl	**cmd_ctrl**	10 10 10 10 10..	**0**	1T
L4/A3	Un-assigned	cmd_ctrl	**cmd_ctrl**	10 10 10 10 10..	**0**	1T
K6/A4	Un-assigned	cmd_ctrl	**cmd_ctrl**	10 10 10 10 10..	**0**	1T
K5/A5	Un-assigned	cmd_ctrl	**cmd_ctrl**	10 10 10 10 10..	**0**	1T
J7/A6	Un-assigned	cmd_ctrl	**cmd_ctrl**	10 10 10 10 10..	**0**	1T
J6/A7	Un-assigned	cmd_ctrl	**cmd_ctrl**	10 10 10 10 10..	**0**	1T
J5/A8	Un-assigned	cmd_ctrl	**cmd_ctrl**	10 10 10 10 10..	**0**	1T
H5/A9	Un-assigned	cmd_ctrl	**cmd_ctrl**	10 10 10 10 10..	**0**	1T
J3/A10	Un-assigned	cmd_ctrl	**cmd_ctrl**	10 10 10 10 10..	**0**	1T
G5/A11	Un-assigned	cmd_ctrl	**cmd_ctrl**	10 10 10 10 10..	**0**	1T
H4/A12	Un-assigned	cmd_ctrl	**cmd_ctrl**	10 10 10 10 10..	**0**	1T
F4/A13	Un-assigned	cmd_ctrl	**cmd_ctrl**	10 10 10 10 10..	**0**	1T
G4/A14	Un-assigned	cmd_ctrl	**cmd_ctrl**	10 10 10 10 10..	**0**	1T
L7/BA0	Un-assigned	cmd_ctrl	**cmd_ctrl**	10 10 10 10 10..	**0**	1T
L6/BA1	Un-assigned	cmd_ctrl	**cmd_ctrl**	10 10 10 10 10..	**0**	1T

U0 Parameters Setup

1. Select to highlight the nets **A0** – **WE_B** under **U0** .
2. Click the icon in the field of **I/O Selection** column and select **Output** from the drop-down list.

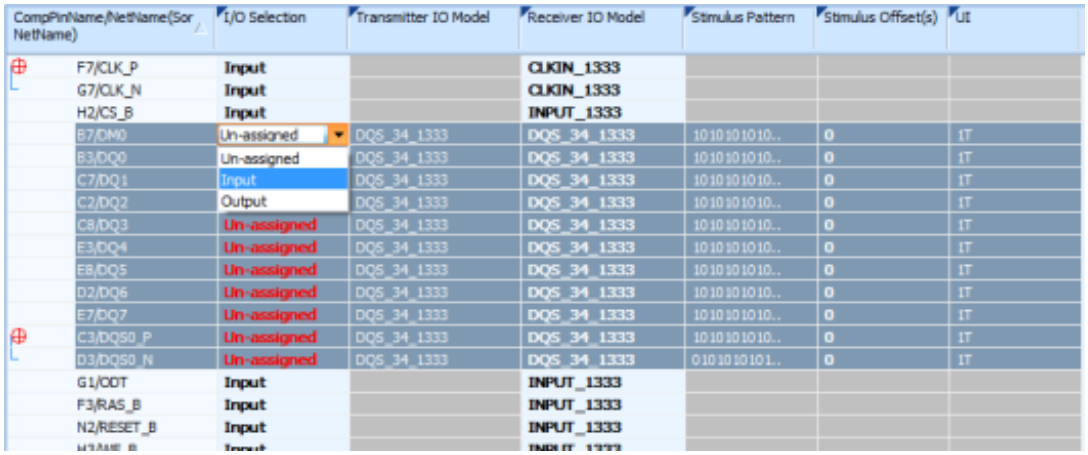


3. Select to highlight nets **DM0** – **DQS3_N** .
4. Click the icon in the field of **UI** column and input **0.5T** in the field.

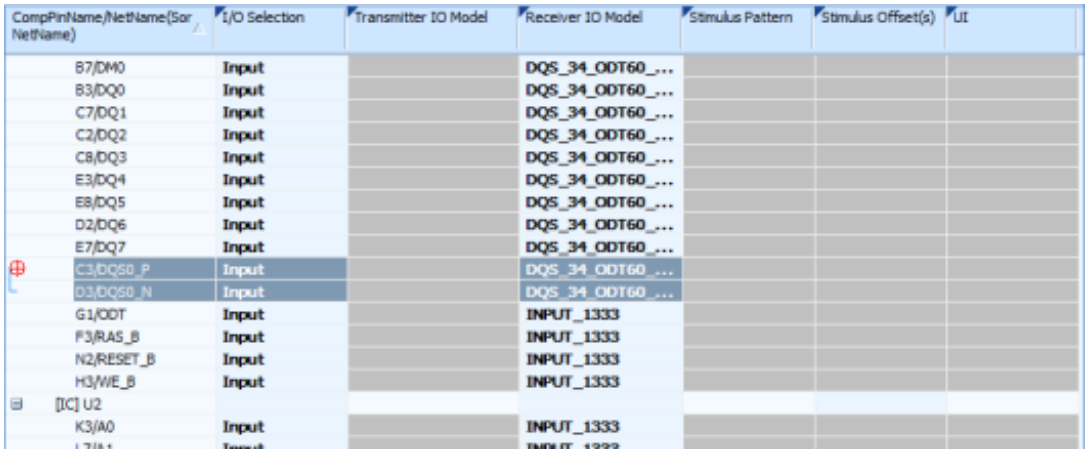


U1 Parameters Setup

1. Select to highlight nets **DM0 – DQS0_N** under **U1** .
2. Click the icon in the field of **I/O Selection** column and select **Input** from the drop-down list.

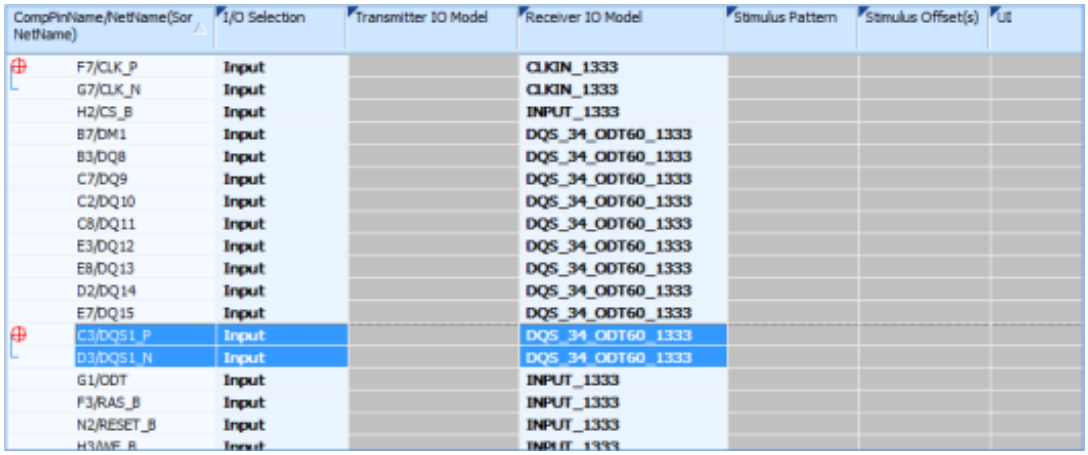


3. Assign the nets **DM0 – DQ7** with the **Receiver IO Model DQ_34_ODT60_1333** from the drop-down list.
4. Assign the nets **DQS0_P – DQS0_N** with **Receiver IO Model DQS_34_ODT60_1333** from the drop-down list.



U2 Parameters Setup

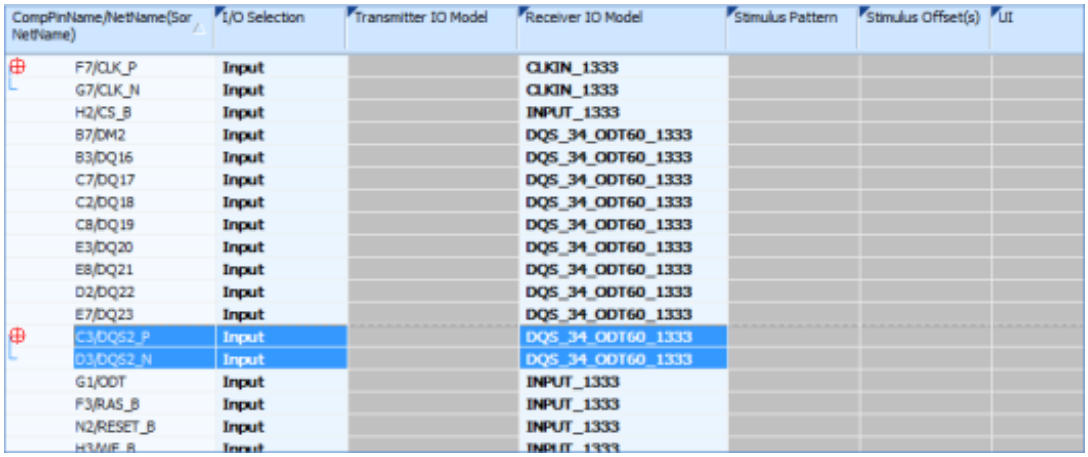
1. Select to highlight nets **DM1 – DQS1_N** under **U2** .
2. Click the icon in the field of **I/O Selection** column and select **Input** from the drop-down list.
3. Assign the nets **DM1 – DQ15** with the **Receiver IO Model DQ_34_ODT60_1333** from the drop-down list.
4. Assign the nets **DQS1_P – DQS1_N** with **Receiver IO Model DQS_34_ODT60_1333** from the drop-down list.



CompPinName/NetName(Sor NetName)	I/O Selection	Transmitter IO Model	Receiver IO Model	Stimulus Pattern	Stimulus Offset(s)	UI
F7/CLK_P	Input		CLKIN_1333			
G7/CLK_N	Input		CLKIN_1333			
H2/CS_B	Input		INPUT_1333			
B7/DM1	Input		DQS_34_ODT60_1333			
B3/DQ8	Input		DQS_34_ODT60_1333			
C7/DQ9	Input		DQS_34_ODT60_1333			
C2/DQ10	Input		DQS_34_ODT60_1333			
C8/DQ11	Input		DQS_34_ODT60_1333			
E3/DQ12	Input		DQS_34_ODT60_1333			
E8/DQ13	Input		DQS_34_ODT60_1333			
D2/DQ14	Input		DQS_34_ODT60_1333			
E7/DQ15	Input		DQS_34_ODT60_1333			
C3/DQS1_P	Input		DQS_34_ODT60_1333			
D3/DQS1_N	Input		DQS_34_ODT60_1333			
G1/ODT	Input		INPUT_1333			
F3/RAS_B	Input		INPUT_1333			
N2/RESET_B	Input		INPUT_1333			
H3/WE_B	Input		INPUT_1333			

U3 Parameters Setup

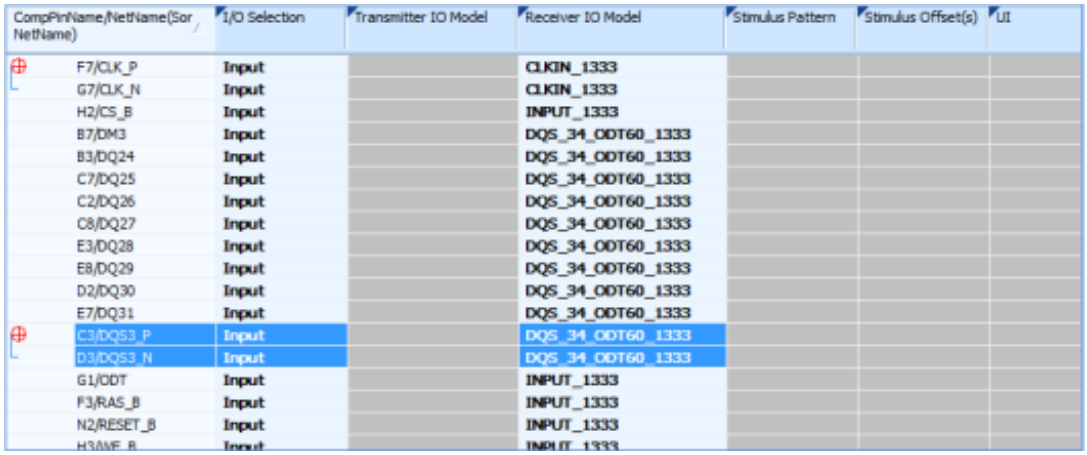
1. Select to highlight nets **DM2 – DQS2_N** under **U3** .
2. Click the icon in the field of **I/O Selection** column and select **Input** from the drop-down list.
3. Assign the nets **DM2 – DQ23** with the **Receiver IO Model DQ_34_ODT60_1333** from the drop-down list.
4. Assign the nets **DQS2_P – DQS2_N** with **Receiver IO Model DQS_34_ODT60_1333** from the drop-down list.



CompPinName/NetName(Sor NetName)	I/O Selection	Transmitter IO Model	Receiver IO Model	Stimulus Pattern	Stimulus Offset(s)	UI
F7/CLK_P	Input		CLKIN_1333			
G7/CLK_N	Input		CLKIN_1333			
H2/CS_B	Input		INPUT_1333			
B7/DM2	Input		DQS_34_ODT60_1333			
B3/DQ16	Input		DQS_34_ODT60_1333			
C7/DQ17	Input		DQS_34_ODT60_1333			
C2/DQ18	Input		DQS_34_ODT60_1333			
C8/DQ19	Input		DQS_34_ODT60_1333			
E3/DQ20	Input		DQS_34_ODT60_1333			
E8/DQ21	Input		DQS_34_ODT60_1333			
D2/DQ22	Input		DQS_34_ODT60_1333			
E7/DQ23	Input		DQS_34_ODT60_1333			
C3/DQS2_P	Input		DQS_34_ODT60_1333			
D3/DQS2_N	Input		DQS_34_ODT60_1333			
G1/ODT	Input		INPUT_1333			
F3/RAS_B	Input		INPUT_1333			
N2/RESET_B	Input		INPUT_1333			
H3/WE_B	Input		INPUT_1333			

U4 Parameters Setup

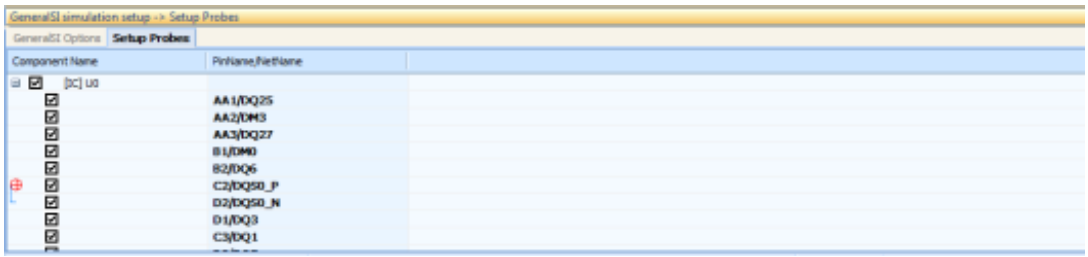
1. Select to highlight nets **DM3 – DQS3_N** under **U4** .
2. Click the icon in the field of **I/O Selection** column and select **Input** from the drop-down list.
3. Assign the nets **DM3 – DQ31** with the **Receiver IO Model DQ_34_ODT60_1333** from the drop-down list.
4. Assign the nets **DQS3_P – DQS3_N** with **Receiver IO Model DQS_34_ODT60_1333** from the drop-down list.



5. Click **OK** to save all settings.

Probes Setup

1. Click **Set up Probes** in the **Workflow** pane.
   The **GeneralSI simulation setup -> Setup Probes** pane appears at the bottom of the window.

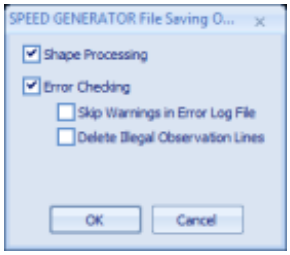


   You can also open the pane by clicking the **Setup Probes** tab in the above section.
   In this example, keep all the probes checked.
2. Go back to the **GeneralSI simulation setup -> GeneralSI Options** pane.
3. Check all models and click **OK** to exit the pane.

Saving File

When all settings are complete, you can:

1. Click **Save File** in the **Workflow** pane to save the .spd files.
   A message window opens for you to confirm the selections.



2. Click **OK** with the default settings.

4

Simulation and Results

Click **Start Simulation** in the **Workflow** pane to perform simulation.

When simulation completes, the result waveforms are shown below.